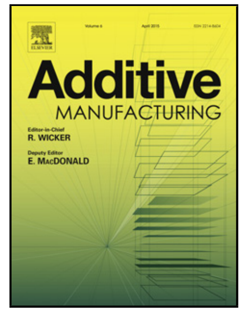

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Nozzle Clogging Factors During Fused Filament Fabrication of Spherical Particle Filled Polymers

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*Highlights*Experiment to identify influence factors of nozzle clogging

- Identification of reasons causing clogging of sphere-filled polycarbonate
- Dimensionless number to describe intermittent clogging
- Model for the occurrence of nozzle clogging

Mathematical viscosity model to approximate printability of materialsTGA	thermogravimetric analysis
MVR	melt volume rate $[\mathrm{cm}^3/10\mathrm{min}]$
PC	polycarbonate

Abstract

Fused filament fabrication with reinforced or filled polymers provides improved material properties compared to ordinary feedstock. A current limitation of these materials is the occurrence of nozzle clogging at higher filler contents. In this work, an experiment is designed to identify the factors causing nozzle clogging. Glass sphere-filled polycarbonate is investigated by varying nozzle and filler diameters, the resin viscosity, the filler content, and the extrusion pressure. Equations identifying nozzle clogging and intermittent clogging conditions are provided. Based on these results, a model for the clogging of sphere-filled polymers is proposed. Last, a mathematical model is derived, which approximates the printability of filled polymers without the preparation of composites. This model is based on the nozzle geometry, the filler type and content, the resin viscosity, and the printer's maximum extrusion force.

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Abbreviations

NOFT	nozzle flow test device

Keywords: fused filament fabrication; glass spheres; polymer composite; polycarbonate; nozzle clogging; clogging model for spheres; viscosity model for printability

1. Introduction

Fused Filament Fabrication (FFF) is a well-established Additive Manufacturing (AM) technology with models ranging from low cost home printers up to an industrial scale [1]. It allows manufacturing nearly any shape with virtually no additional cost for increasing geometric complexity, and has less waste than conventional manufacturing processes [2]. The high flexibility of this process and its low investment costs make it a potential technology for future tailored and customized production close to the point of use [3]. To produce functional parts, new materials with better mechanical properties need to be

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